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Image Optimization and Segmentation by Selective Fusion in K-Means Clustering

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***Abstract* – We present a simple, reduced-complexity and efficient image segmentation and fusion approach. It optimizes the segmentation process of colored images by fusion of K-means clusters in various color spaces, in order to finally get a more reliable, accurate and a non-overlapped image. The initial segmentation maps are produced by taking a local histogram of each pixel and allocating it to a bin in the re-quantized color space. The pixels in the re-quantized color spaces are clustered into classes using the K-means (Euclidean Distance) technique. K-means clustering tends to find clusters of comparable spatial extent, while the expectation-maximization mechanism allows clusters to have different shapes and a selective fusion procedure is followed to reduce the computational complexity and achieve a better-segmented image. The parameters considered for selection of initial segmentation maps include entropy, standard deviation, and spatial frequency etc. The performance of the proposed method is analyzed by applying on various images from the Berkeley image database. The result aims at developing an accurate and more reliable image as compared to other methods along with reduced complexity, processing time and hardware resources required for real-time implementation.**

***Keyword s-* Genetic algorithm, color spaces, fusion, image segmentation, K-Means algorithm, Optimization, Berkeley image database.etc.**

I. INTRODUCTION

The process of image segmentation decomposes an image into easy to understand regions or components based on similarity in attributes like color or texture etc. It stands as a critical step in many applications of image processing in the areas of computer vision, pattern recognition, machine learning etc. It stands as a critical step in many applications of image processing, computer vision and machine learning etc. Major applications using image segmentation include edge detection, object recognition, image retrieval, compression, object tracking and image understanding. Among the various segmentation techniques, clustering approaches like K-means clustering are the most commonly used because of their efficiency and simplicity.

K-means clustering (called Lloyd's algorithm) is an iterative algorithm that divides n observations into k clusters such that each observation is assigned to the cluster whose centroid has the minimum distance to that observation than any other centroid. Segmentation of colored images has gained tremendous importance over the years especially in the areas of video surveillance and motion detection. Colored image segmentation, being complex and computationally intensive, requires fast and efficient algorithms. Lately, various techniques of colored image segmentation have been proposed. The idea of colored image segmentation through a fusion of histogram-based K-means clusters was initially proposed. The paper was reviewed and the research was advanced for edge detection. However, the methods proposed required considerable processing time and hardware resources for implementation and were largely similar in terms of results. In this paper, we discuss an efficient and simple to implement segmentation approach that achieves better-segmented image simultaneously addressing the issues related to processing time and hardware resources required for real-time implementation.

The input colored image is converted into six different color spaces to take advantages of the properties associated with each. Initial segmentation maps are created by taking a local color histogram of each pixel, based on the color content of the pixel and its immediate neighborhood pixels and then assigning each pixel to a bin in the re-quantized color space.

The re-quantized color histogram of the image is clustered using K-means clustering in each of the color spaces. The initial segmentation maps thus produced are fused together to produce a final segmented image. An optimized approach for fusion of selected segmentation maps is adopted that results in higher entropy in the resulting segmented image. An analysis of experimental

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results through performance measuring parameters indicate improvement in visual output coupled with better indicators for reduced complexity, processing time and requirement of hardware resources. The initial Segmentation process is explained in Section II of this paper. Section III describes the fusion of Segmentation Maps, Section IV gives experimental results/ analysis and Section V concludes the discussion.

II.INITIAL SEGMENTATION PROCESS

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). Segmentation refers to the process of partitioning a digital image into multiple regions (sets of pixels). The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images.

The result of image segmentation is a set of regions that collectively cover the entire image or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s). Segmentation is mainly used in medical imaging, Face recognition, Fingerprint recognition, Traffic control systems, Brake light detection, and Machine vision.

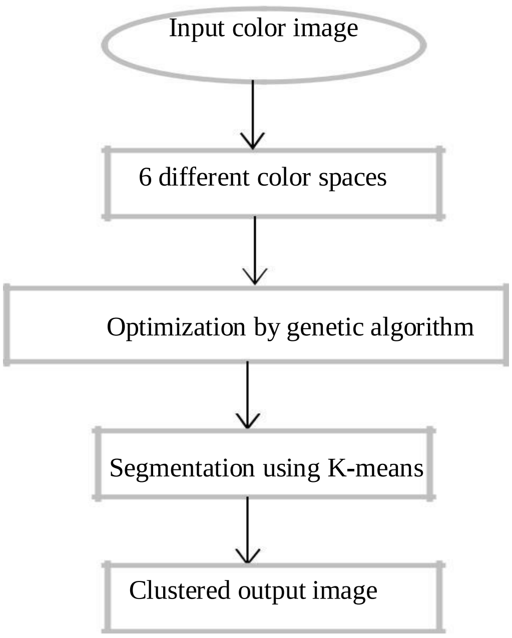

Fig. 1 Flow chart for obtaining clustered image.

III. COLOR SPACE CONVERSION

Color is the brains reaction to a specific visual stimulus. Color can be described by measuring its spectral power distribution (the intensity of the visible electro-magnetic radiation at many discrete wavelengths) this leads to a large degree of redundancy.

The reason for this redundancy is that the eye's retina samples color using only three broad bands, roughly corresponding to red, green and blue light. The signals from these color sensitive cells (cones), together with those from the rods (sensitive to intensity only), are combined in the brain to give several different sensations of the color.

1. Different color spaces

The image first considered is a color image; color image is taken because this image is further divided into different color spaces. Different colors provide different properties in special. A color image gives detailed information about the image and an attractive way of producing an image. Thus a color image is considered, it can a JPEG, BMP image. The color space may be device dependent and device independent, according to CIE standard six color spaces namely rgb, yiq, xyz, hsv, luv, lab are considered.

2. RGB (Red Green Blue)

This is an additive color system based on tri-chromatic theory. RGB is easy to implement but non–linear with visual perception. It is device dependent and specification of colors is semi– intuitive. RGB is very common, being used in virtually every computer system as well as television, video etc.

3. Hue Saturation Value (Travis)

These are the RGB-HSV conversions given by Travis. To convert from RGB to HSV (assuming normalized RGB values) first find the maximum and minimum values from the RGB triplet.

s= (max-min)/max and Value is V=max

The Hue, H is then calculated as follows. First calculate R'G'B'. Conditions is given by,

R'= (max-R)/ (max-min)

G'= (max-G)/ (max-min)

B'= (max-B)/ (max-min)

Hue, H, is then converted to degrees by multiplying by 60 giving HSV with S and V between 0 and 1 and H between 0 and 360.

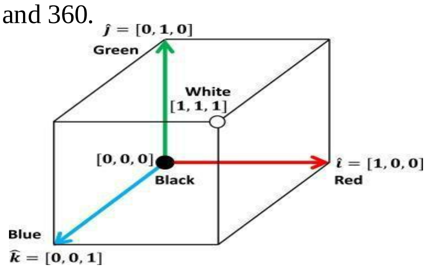

Fig .2 Segmentation of images by RGB colors.

The various color spaces being used present some unique properties which can be optimally combined to produce a better segmented image. RGB is a tri-chromatic additive color system, suitable for tracking applications. The HSV decomposes the chrominance and shading information. YIQ space codes luminance and chrominance and is used in image compression.

XYZ color space is linear in terms of human psychological and visual perception. LAB color space tends to approach human perception of lightness. LUV color space provides uniform spacing between colors based on Euclidean distance

IV. FUSION OF SEGMENTATION

In this research paper, the advantages offered by six color spaces are combined by fusing the six initial segmentation maps corresponding to each of the six color spaces. The fusion has been carried out using four spatial domain techniques. Fusion by simple averaging; all segmentation maps are given same weight age in the fusion.

More weight, though the weights are still assigned arbitrarily by the user. Entropy-based weighted averaging; weights are assigned to each segmentation maps in proportion to its entropy contribution towards the total entropy for all color spaces.

Entropy-based weighted averaging for three color spaces; three segmentation maps with maximum entropy are selected and weights are assigned in proportion to entropy contribution of each towards the total entropy for the three. The Bhattacharya distance between these two histograms is given as,

$$BC(\mathbf{p},\mathbf{q}) = \sum_{i=1}^{n} \sqrt{p_i q_i},$$

1. K-Means Algorithm

Iterative, hard, flat clustering algorithm based on Euclidean distance
Specify k, the number of clusters to be generated
Choose k points at random as cluster centers.
Assign each distance to its closest cluster center using Euclidean distance
Calculate the centroid(mean) for each cluster, use it as a new cluster center
Reassign all instances to the closest cluster center
Iterate until the cluster centers don't change anymore

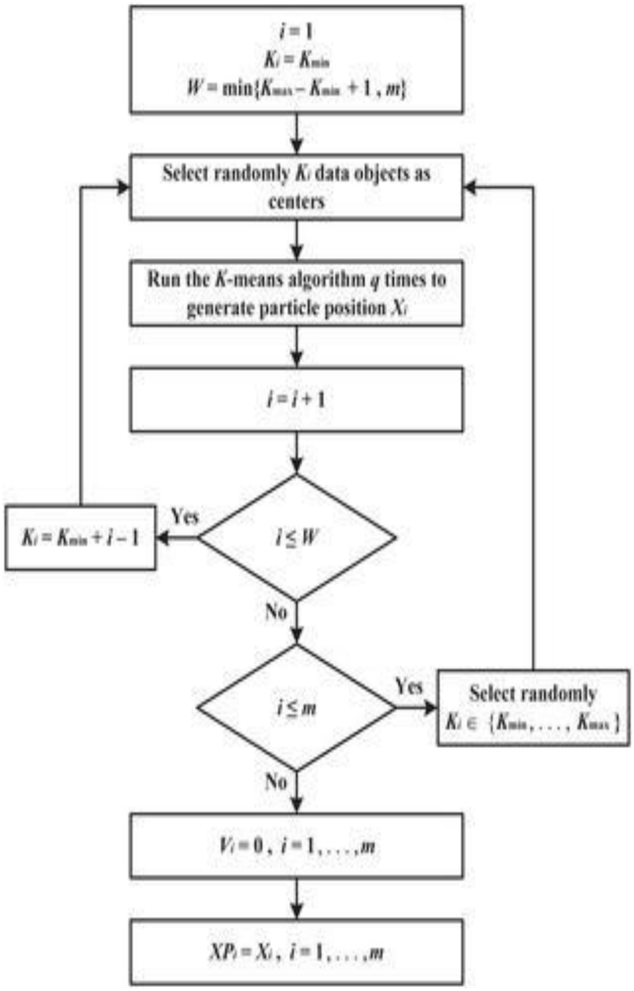

Fig. 3 Flow chart for k-Means Algorithm.

V. IMAGES USING K-MEANS SEGMENTATION

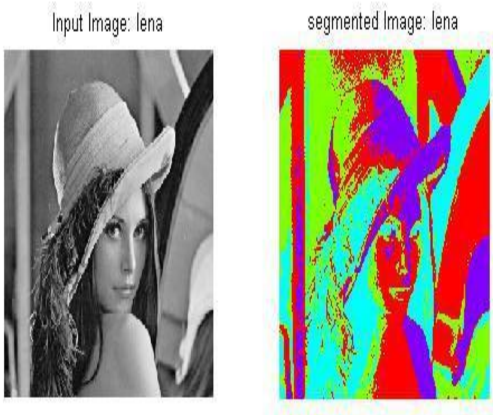

Fig. 4 Images using k-means segmentation.

VI. PERFORMANCE MEASURES

Table1 Performance of means for Reduced K-means (RKM), scaling K-means and Std K-means algorithm.

Data set			Algorithm		
d	k	η	RKM	Scal K-means	Std K-means
10	10	1%	1.161	1.499	1.637
10	20	1%	1.094	1.490	1.538
20	10	1%	2.431	4.122	3.497
40	10	1%	4.601	7.154	11.216
10	10	10%	1.212	2.144	1.913
20	20	10%	4.432	5.496	5.209
20	40	10%	4.229	5.248	4.805

VII. CONCLUSIONS

Image segmentation of colored images can be effectively achieved by optimized fusion of histogram based k-means clusters of an image in different color spaces. Fusion of three selected segmentation maps with highest entropy values results in a segmented image with highest entropy compared to simple averaging, entropy-trended weighted averaging and entropy-based averaging. Depending on the user requirement, any other evaluation parameter (SD or AG etc.) can be kept as a reference to enhance the value of the parameter in the fused image. The proposed algorithm enhances the visual quality of segmented images; gives better performance metrics compared with the popular image segmentation/ fusion algorithms and reduces the processing time and hardware resources required for real time implementation. The proposed concept can be effectively applied in colored image segmentation problems as required by many computer vision applications.

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